

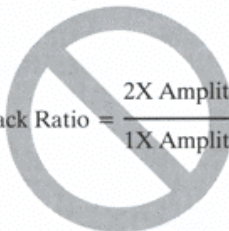


Shaft CenterLINES

The ratio of 2X to 1X vibration - A shaft crack detection myth

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For many years, a myth has circulated in industry that relates the presence of and/or growth of a shaft crack to the ratio of two times synchronous vibration amplitude (2X) to a synchronous vibration amplitude (1X):



$$\text{Crack Ratio} = \frac{2X \text{ Amplitude}}{1X \text{ Amplitude}}$$

The myth states that a crack is present or a crack is growing when this ratio is increasing. If the ratio is constant or if there is no 2X, then there isn't a shaft crack, according to this myth.

Bently Rotor Dynamics Research Corporation (BRDRC) has been "keeping score" on shaft cracks for

more than ten years. Based on this "score card" of actual shaft crack cases, if you follow the **crack ratio** formula, you will be **exactly wrong more than 75% of the time**.

BRDRC, Bently Nevada's Machinery Diagnostics Services, and our customers, have been using a field-proven shaft crack diagnostic methodology for many years. We have found that, in more than 75% of documented cases, the key indicator of shaft cracks is change in 1X amplitude or 1X phase lag angle. While 2X vibration is helpful in crack diagnostics, in more than 25% of cases there was no 2X vibration.

In addition, there are other sources for 2X vibration, such as the effect of a steady side load into a non-linear stiffness bearing or seal when there is some 1X bow. Therefore, the crack ratio can not only fail to predict a crack, it can give false indication of a crack.

The "score card" summarizes the key shaft crack indicators, based on experience. ■

Vibration score card for shaft cracks

Changing parameter	Prevailing indicator in shaft crack cases
1X Amplitude	75% of cases. Nearly always increasing amplitude
1X Phase	Often seen with 1X amplitude, probably rare by itself. Can be leading, lagging or constant phase.
2X Amplitude	25% of cases. Either 2X Amplitude (usually increasing) or Amplitude and Phase changes, depending on rotor system and crack properties.
2X Phase	